

## BIOTECHNICAL ENGINEERING

*Biotechnical Engineering* introduces students to the fundamental aspects of biotechnology and engineering. Instruction will emphasize how engineering and technology processes can be used to create new innovations that will improve the society. Engineering principles will be used in conjunction with scientific knowledge to explore and investigate the field of biotechnology. Students will learn how new technologies are developed and produced and will have opportunities to discuss the impact of these advances on society. Ethical, social, and regulatory issues of biotechnology applications will be addressed throughout the course.

- DOE Code:4818
- Recommended Grade Level: Grade 10-12
- Recommended Prerequisites: Introduction to Engineering Design, Principles of Engineering
- Credits: 1 credit per semester, maximum of 2 credits
- Counts as a Directed Elective or Elective for the General, Core 40, Core 40 with Academic Honors and Core 40 with Technical Honors diplomas
- This course is aligned with postsecondary courses for Dual Credit

### Dual Credit

This course provides the opportunity for dual credit for students who meet postsecondary requirements for earning dual credit and successfully complete the dual credit requirements of this course.

### Application of Content and Multiple Hour Offerings

Intensive laboratory applications are a component of this course and may be either school based or work based or a combination of the two. Work-based learning experiences should be in a closely related industry setting. Instructors shall have a standards-based training plan for students participating in work-based learning experiences.

## Content Standards

### Domain – Safety in the Classroom and Industry

**Core Standard 1** Students apply and adapt safety procedures that connect to industry standards.

#### Standards

- BTE-1.1 Demonstrates safety procedures to protect themselves and others
- BTE-1.2 Illustrates procedures for accurate results in analyzing solutions
- BTE-1.3 Investigate the types of equipment used in the biotechnical industry
- BTE-1.4 Interprets the Material Safety Data Sheets from the materials used in the classroom

### Domain – Utilizing the Design Process and Systems Model

**Core Standard 2** Students apply and adapt the design process to challenges in the biotechnical engineering field.

#### Standards

- BTE-2.1 Identify and describe the steps in the design process
- BTE-2.2 Identify and describe the systems model
- BTE-2.3 Develops solutions to complex design problems using the design process
- BTE-2.4 Demonstrate appropriate documentation and accurate communication of possible solutions

## **Domain – Biotechnical Engineering History and Industry**

**Core Standard 3** Students evaluate historical biotech events to understand current and future industry opportunities.

### **Standards**

- BTE-3.1 Compare the distinguishable advances in the biotechnology industry
- BTE-3.2 Assess the past and current applications of biological and engineering concepts that have been used to design materials and processes that directly measure, repair, improve, and extend living systems
- BTE-3.3 Correlate the historical advances of biotechnical engineering concepts which have led to current innovations and standards
- BTE-3.4 Investigate the rapid rate of new biological discoveries
- BTE-3.5 Explain the correlation between what is happening in the financial markets and what drives the biotechnology industry

## **Domain – Ethics in Biotechnical Engineering**

**Core Standard 4** Students evaluate biotechnical policies and their effects on industry, scientific community, society, and individuals.

### **Standards**

- BTE-4.1 Define the differences between morals, values, and ethics
- BTE-4.2 Understand the importance of confidentiality and patient rights
- BTE-4.3 Know how to properly dispose of biologic waste
- BTE-4.4 Evaluate policy decisions regarding bioethics
- BTE-4.5 Study life sciences by considering the impact of new technologies and the potential to benefit or harm living systems
- BTE-4.6 Justify views of what variables shape one's ethics and how those variables are distributed in society
- BTE-4.7 Identify the controversial nature of bioethical issues
- BTE-4.8 Discuss bioethical issues involving questions of responsibility and obligations to others
- BTE-4.9 Analyze decisions about the use of technology involving weighing the trade-offs between the positive and negative effects

## **Domain – Environmental and Agricultural Engineering**

**Core Standard 5** Students incorporate environmental and agricultural engineering to manage societal and environmental problems.

### **Standards**

- BTE-5.1 Determine the applications of fermentation in food production and renewable energy
- BTE-5.2 Design a method or instrumentation to be used for measuring rates of fermentation
- BTE-5.3 Name whole organisms that can be used as bioreactors to produce useful products
- BTE-5.4 Identify that chemostats are important tools of process engineers that require aseptic techniques and a thorough understanding of microbial metabolism
- BTE-5.5 Investigate reactants or substrates is critical for efficient use of bioreactors
- BTE-5.6 Cite evidence that bioprocessing can lead to novel approaches of renewable energy
- BTE-5.7 Explore genetic engineering and how it affects global economy
- BTE-5.8 Provide a environmental solution to a man-made or environmental problem

## **Domain — Biochemical Engineering**

**Core Standard 6** Students synthesize biochemical information to enhance the human and environmental condition.

### **Standards**

- BTE-6.1 Define bioinformatics
- BTE-6.2 Investigate molecular techniques that are used by bioinformaticists
- BTE-6.3 Analyze the technology utilized in the field of forensics
- BTE-6.4 Apply the skills of reverse engineering in forensics
- BTE-6.5 Create methods for evaluating collected evidence and prepare justification for conclusions
- BTE-6.6 Apply practical knowledge of genetic engineering
- BTE-6.7 Explain the technological advances necessary for the identification and processing of DNA

## **Domain — Biomedical Augmentation**

**Core Standard 7** Students analyze the application of augmentation to improve the quality of life.

### **Standards**

- BTE-7.1 Assess technological evaluations to improve biomedical engineering
- BTE-7.2 Illustrate extensive communication and documentation that is essential throughout the profession
- BTE-7.3 Demonstrate engineering design principles by improving current biotechnical technology
- BTE-7.4 Demonstrate the application of product liability, reliability, reusability, and failure
- BTE-7.5 Research anatomy and its function
- BTE-7.6 Identify and describe the common diseases and disorders of muscular, neurological, circulatory systems, and skeletal anatomy
- BTE-7.7 Justify how the use of artificial implants and orthopedic devices can help to overcome common diseases and disorders
- BTE-7.8 Evaluate a variety of specialized materials that can be used for replacement devices
- BTE-7.9 Identify and describe human birth defects that can be corrected using prosthetic devices to improve the quality of life
- BTE-7.10 Interpret procedures involving surgery and the cost of a proposed noninvasive or invasive implants
- BTE-7.11 Assess current imaging techniques and design improvements for those techniques

## **Domain — Careers in Biotechnical Engineering**

**Core Standard 8** Students evaluate the availability of biotechnical engineering careers and opportunities.

### **Standards**

- BTE-8.1 Identify and describe biotechnical engineering careers
- BTE-8.2 Compare biotechnical engineering opportunities offered by a technical school or college
- BTE-8.3 Determine biotechnical engineering occupation wages/salaries
- BTE-8.4 Evaluate job outlook information on various biotechnical engineering careers
- BTE-8.5 Develop a biotechnical career path

## Process Standards

### Common Core Literacy Standards for Technical Subjects

#### Reading Standards for Literacy in Technical Subjects 9-10

The standards below begin at grade 9 and define what students should understand and be able to do by the end of grade 10. The CCR anchor standards and high school standards in literacy work in tandem to define college and career readiness expectations – the former providing broad standards, the latter providing additional specificity.

#### Key Ideas and Details

- 9-10.RT.1 Cite specific textual evidence to support analysis of technical texts, attending to the precise details of explanations or descriptions.
- 9-10.RT.2 Determine the central ideas or conclusions of a text; trace the text's explanation or depiction of a complex process, phenomenon, or concept; provide an accurate summary of the text.
- 9-10.RT.3 Follow precisely a complex multistep procedure when performing technical tasks, attending to special cases or exceptions defined in the text.

#### Craft and Structure

- 9-10.RT.4 Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific context relevant to *grades 9-10 texts and topics*.
- 9-10.RT.5 Analyze the structure of the relationships among concepts in a text, including relationships among key terms (e.g., *force, friction, reaction force, energy*).
- 9-10.RT.6 Analyze the author's purpose in providing an explanation, describing a procedure, or discussing an experiment in a text, defining the question the author seeks to address.

#### Integration of Knowledge and Idea

- 9-10.RT.7 Translate technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.
- 9-10.RT.8 Assess the extent to which the reasoning and evidence in a text support the author's claim or a recommendation for solving a technical problem.
- 9-10.RT.9 Compare and contrast findings presented in a text to those from other sources (including their own experiments), noting when the findings support or contradict previous explanations or accounts.

#### Range of Reading and Level of Text Complexity

- 9-10.RT.10 By the end of grade 10, read and comprehend technical texts in the grades 9-10 text complexity band independently and proficiently

#### Writing Standards for Literacy in Technical Subjects 9-10

The standards below begin at grade 9 and define what students should understand and be able to do by the end of grade 10. The CCR anchor standards and high school standards in literacy work in tandem to define college and career readiness expectations – the former providing broad standards, the latter providing additional specificity.

#### Text Types and Purposes

- 9-10.WT.1 Write arguments focused on *discipline-specific content*.
- 9-10.WT.2 Write informative/explanatory texts, including technical processes.
- 9-10.WT.3 Students will not write narratives in technical subjects. *Note: Students' narrative skills continue to grow in these grades. The Standards require that students be able to incorporate narrative elements effectively into arguments and informative/explanatory texts. In technical, students must be able to write precise enough descriptions of the step-by-step procedures they use in their technical work that others can replicate them and (possibly) reach the same results.*

#### **Production and Distribution of Writing**

- 9-10.WT.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
- 9-10.WT.5 Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience.
- 9-10.WT.6 Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology's capacity to link to other information and to display information flexibly and dynamically.

#### **Research to Build and Present Knowledge**

- 9-10.WT.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
- 9-10.WT.8 Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the usefulness of each source in answering the research question; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and following a standard format for citation
- 9-10.WT.9 Draw evidence from informational texts to support analysis, reflection, and research.

#### **Range of Writing**

- 9-10.WT.10 Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

#### **Career and Technical Student Organizations**

Career and Technical Student Organizations are considered a powerful instructional tool when integrated into Career and Technical Education programs. They enhance the knowledge and skills students learn in a course by allowing a student to participate in a unique program of career and leadership development. Students should be encouraged to participate in a Career and Technical Student Organization, such as **Business Professional of America, DECA, or Future Business Leaders of America.**